



Emergency Disinfection of Small Systems

Has your system lost pressure lately due to a power outage, failed pumping system, main break, or other unusual event? Or have you just learned you have an Acute or Non-Acute Total Coliform Rule MCL violation? If so, and if you normally provide water that is not disinfected, please read on.

When to disinfect

A water system should be disinfected any time it experiences any of the following:

- The system loses pressure for any reason.
- Any part of the system is “opened up” for maintenance or repairs.
- Backflow or back-siphonage creates a cross-connection event.
- Total coliform, fecal coliform, or E. coli is found present in both routine and repeat coliform samples.

A system should also be batch chlorinated if multiple routine coliform samples in one month show the presence of total coliform, fecal coliform, or E. coli. This disinfection should not occur until after the required repeat samples have been collected for each of the unsatisfactory routine samples.

Notify your customers first

Before disinfecting any system that is normally not disinfected, you must notify all users. Of special concern are people with unique medical needs, such as kidney dialysis patients. All water systems should maintain a list of such customers. People with aquariums or ponds that contain fish will also want to know that the water is to be chlorinated.

Note: This document is primarily written for smaller, non-municipal type systems, though the information may be helpful to any system. The document discusses how to disinfect both for a simple groundwater system with pressure tanks and distribution pipes, as well as a system with a storage reservoir. The first four steps are different for the two kinds of systems, but steps 5-8 are identical.

Adding chlorine to a groundwater source

1. Calculate the volume of water in the well or spring box. To do this, multiply the number of cubic feet by 7.5 to determine the number of gallons. (Or use the table on the next page.)



HELPING TO ENSURE SAFE AND RELIABLE DRINKING WATER

CALCULATING WELL VOLUME	
Well Casing Diameter (inches)	Volume (gallons per vertical foot of water)
6	1.5
8	2.6
10	4.1
12	5.9
14	8.0
16	10
36	53

- Calculate how much chlorine to add to the well or spring box, using this table:

WELL DISINFECTION: Amount of chlorine bleach to use				
Well Volume (gallons)	Desired Chlorine Dosage			
	5 ¼ % bleach			12 % bleach
	5 ppm	20 ppm	50 ppm	5 ppm
50	1 ¼ Tbsp.	¼ cup	1 cup	½ Tbsp.
100	2 ½ Tbsp.	½ cup	1 ½ cups	1 Tbsp.
150	¾ cup	1 cup	2 ¼ cups	1 ½ Tbsp.
200	5 Tbsp.	1 ¼ cups	3 cups	2 Tbsp.
250	6 Tbsp.	1 ½ cups	4 cups	3 Tbsp.
500	¾ cup	3 cups	½ gallon	5 Tbsp.
750	1 ¼ cup	4 ½ cups	¾ gallon	½ cup
1000	1 ½ cup	6 cups	1 gallon	¾ cup

(Also see the boxed information on the last page of this document: *What chlorine dose is needed?*) If your distribution system is extensive, consider the volume of water in the distribution piping when determining how much chlorine to use.

- Pour the required quantity of bleach into the well or spring box.
- Connect a brand new garden hose to the nearest outside faucet and circulate the water through the hose and back into the source. This will mix the chlorine with the water, and the pump will draw the chlorine to the bottom of the well. After you start smelling the chlorine in the water coming out of the hose, use the hose to rinse the upper portion of the well with the disinfectant. Note: If you cannot reach the well with the hose, mix one cup chlorine bleach per bucket of water and pour chlorinated water down the inside of the casing. The bucket method will also work when you are disinfecting a gravity-flow spring box.

Now proceed to Step 5, next page.

Adding chlorine to a storage reservoir

Note: If you must chlorinate both your source and your storage reservoir, disinfect the reservoir and distribution system first, and then do the source and the pipe leading to the reservoir. This will ensure adequate disinfection of the source.

- If the contamination does not appear to be originating at the water source, the system may be disinfected by adding disinfectant to the storage reservoir rather than the water source.

- Determine the amount of chlorine that will need to be added to the storage tank, using the table below:

RESERVOIR DISINFECTION: Amount of chlorine bleach to use				
Reservoir Volume (gallons)	Desired Chlorine Dosage			
	5 ¼ % bleach			12 % bleach
	1 ppm	20 ppm	50 ppm	1 ppm
5,000	1 ½ cups	2 gallon	5 gallon	1 cup
10,000	3 cups	4 gallon	10 gallon	1 ¼ cups
15,000	4 ½ cups	6 gallon	14 gallon	2 cups
20,000	6 cups	8 gallon	19 gallon	3 cups
25,000	½ gallon	10 gallon	24 gallon	3 ¼ cups
50,000	1 gallon	19 gallon	48 gallon	7 cups
75,000	1 ½ gallon	29 gallon	71 gallon	10 cups
100,000	1 ¾ gallon	38 gallon	95 gallon	¾ gallon

(Also see the boxed information on the last page of this document: *What chlorine dose is needed?*) If your distribution system is extensive, the volume of water in the distribution piping should be considered when determining how much chlorine to use.

- Draw down the level of water in the storage tank, but keep sufficient quantity for fire flow, if required.
- Pour the chlorine into the tank as the tank is refilling, in order to get some mixing.

Steps 5-8 are identical for both types of disinfection operations.

- Beginning with the outlet closest to the point of chlorine addition (that is, either the source or the reservoir) draw water at every outlet until you can smell chlorine. To be more accurate, use a chlorine residual test kit. DOH recommends that every water system own such a kit. Turn off each outlet once chlorine is detected.
- Allow the chlorine to remain in the system overnight (24 hours is preferable.) Chlorine needs time to do an effective job of disinfecting.
- Use one or more outside faucets, blow-offs, hydrants, etc. to draw water out of the system to remove the chlorine. The system should be thoroughly and repeatedly flushed to remove the chlorine. During this process, make sure you don't damage a pump by drawing water down below the pump intake. Chlorinated water is extremely toxic to fish. It should never be discharged to any water body, wetland, or drainage ditch. High chlorine residuals must be dechlorinated before discharge.
- After following this procedure and rendering the water completely free of disinfectant, you should wait a minimum of seven days following disinfection before collecting a bacteriological sample. (Note: If you are disinfecting in follow-up to an Acute Total Coliform Rule MCL violation, you should be working with the DOH Regional Office Coliform or Engineering staff to determine when coliform sampling should occur relative to chlorination and flushing.) The chlorine residual should be measured and noted on the coliform lab slip whenever coliform samples are collected. In follow-up to an emergency disinfection event, the measurement of a zero residual is worthy of note too. The bacteriological analysis will indicate whether or not the system disinfection was effective.

If you have any questions about disinfecting your system, please call your DOH regional engineer or coliform program staff member:

Northwest Regional Office:	Carol Stuckey or Jennifer Prodzinski	253-395-6775
Southwest Regional Office:	Sandy Brentlinger	360-753-5090
Eastern Regional Office:	Pat McCaffery	509-456-2788

Other, more detailed references regarding disinfection of water system facilities include:

- American Water Works Association (AWWA) Standard C564-87, "Disinfection of Wells"
- AWWA Standard C651-92, "Disinfecting Water Mains"
- AWWA Standard C652-92, "Disinfection of Water-Storage Facilities"

These AWWA standards assume that the component being disinfected, such as a well or storage tank, is isolated from the rest of the system during the disinfection. For this reason, these references discuss chlorine doses significantly higher than those discussed above. Such high dose should not be used if there is a chance that any water system user could consume, or otherwise utilize, the water.

What chlorine dose is needed?

A chlorine dose of 1 to 2 ppm (mg/L) should be sufficient whenever contamination is suspected (such as following a pressure loss due to a power outage) or in response to a Non-Acute MCL violation of the Total Coliform Rule. In some cases when responding to a Non-Acute violation, this dose may not be sufficient and a larger dose such as 3 to 4 ppm might be needed. Larger doses may be required in response to an Acute MCL violation of the Total Coliform Rule or when a known bacteriological cross-connection has occurred. Please consult with your DOH regional office in these cases.

Note: There is a regulatory maximum chlorine residual for systems that disinfect full-time. That maximum residual is 4 ppm. It is therefore recommended that for emergency disinfection, the chlorine dose be such that this maximum is not surpassed.

Notes related to the tables

Volume of bleach needed, $V_1 = (C_2 \times V_2) / C_1$, in gallons, where

C_2 = desired chlorine dose, ppm

V_2 = the volume water to be treated, gallons

C_1 = the concentration of the bleach solution, ppm

Well volume = $7.48 \times H \times 3.14 \times (D/12)^2 / 4$, in gallons, where

H = the height of water standing in the well, in feet

D = the well casing diameter, in inches

5 ¼ % household bleach contains 52,500 ppm hypochlorite

12 % bleach contains 120,000 ppm hypochlorite

1 cubic foot of water = 7.48 gallons

1 gallon = 16 cups

1 cup = 16 tablespoons (Tbsp.) or 8 fluid ounces

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